sidewalls and the top and bottom walls, the beam can have horizontal and vertical polarization and the shutter switch 182 can block one or both of the polarizations. When the high impedance structure has multiple layers, the shutter switch can be transparent or block signals at multiple frequencies and at one or both polarizations.

Claims

Replace the corresponding claims in the original application with the following amended claims:

1. A shutter switch for an electromagnetic wave beam, comprising:

a plurality of waveguides adapted to receive at least part of an electromagnetic beam, said waveguides having sidewalls with alterable impedance properties, said waveguides being adjacent to one another with their longitudinal axes aligned with the propagation of said beam each of said waveguides switchable to alter the impedance properties of its sidewalls to either transmit or block transmission of its respective portion of said beam.

2. A shutter switch for an electromagnetic wave beam, comprising:

a plurality of waveguides adapted to receive at least part of an electromagnetic beam, said waveguides being adjacent to one another with their longitudinal axes aligned with the propagation of said beam, said waveguides switchable to either transmit or block transmission of their respective portions of said beam, wherein each of said waveguides comprises:

four wall inside surfaces comprising two opposing sidewalls and a top and bottom wall;

respective high impedance wall structures on at least two opposing walls, said wall structures presenting a high surface impedance to E fields transverse to the waveguide axis and tangential to the said opposing wall structure, and a low impedance to E fields parallel to the waveguide axis; and

shorting arrangements on each said wall structures to short circuit their high impedances;

each of said waveguides having internal dimensions to cut-off the transmission of its respective portion of said beam when its high impedance wall structure is short circuited to a low impedance state.

3. The shutter switch of claim 2, wherein each said high impedance wall structure comprises:

a sheet of dielectric material having two sides;

a conductive layer on one outer side of said dielectric material;

a plurality of mutually spaced conductive strips on the other inner side of said dielectric material, said strips having gaps between adjacent said strips and being aligned parallel to the guide longitudinal axis; and

a plurality of conductive vias extending through said dielectric material between said conductive layer and said conductive strips.

5. The shutter switch of claim 3, wherein adjacent pairs of said strips present a capacitance and said dielectric sheet presents an inductance to an electromagnetic beam with an E field transverse and tangential to said conductive strips.

6. The shutter switch of claim 5, wherein said conductive strips and dielectric material present a series connection of parallel L-C circuits, resonant at an operating frequency, to an electromagnetic beam with an E field transverse and tangential to said conductive strips.

8. The shutter switch of claim 3, wherein said high impedance structure are provided on said waveguide's sidewalls and present a high impedance to the E field component of a vertically polarized guided beam.

9. The shutter switch of claim 3, wherein said high impedance structure are provided on said waveguide's top and bottom walls and present a high impedance to the E field component of a horizontally polarized guided beam.

10. The shutter switch of claim 3, wherein said high impedance structure are provided on said waveguide's sidewalls and top and bottom walls and present a high impedance to the E field component of both vertically and horizontally polarized beams.

11. The shutter switch of claim 3, wherein said shorting arrangements change said high surface impedance structure to a conductive surface by shorting said gaps between said conductive strips.

12. The shutter switch of claim 11, wherein said shorting arrangements comprise micro electromechanical systems (MEMS) switches.

13. The shutter switch of claim 12, wherein each of said

MEMS shorting arrangements comprises a shorting strip suspended over said gap between a respective pair of said conductive strips, said gap being shorted by applying a voltage potential to adjacent electrodes creating an electrostatic tension that pulls said shorting strip down to said conductive strips to form a conductive bridge across said gap between said conductive strips.

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14. The shutter switch of claim 11, wherein said shorting comprise varactor diode in each of said gaps.

15. The shutter switch of claim 14, wherein each of said varactor diode places a variable capacitance across its respective said gap such that a voltage may be applied to detune the parallel L-C circuits away from said operating frequency thus rendering the high surface impedance to a low impedance state and causing a cut-off state for said guide at said operating frequency.

16. The shutter switch of claim 2, wherein said high impedance wall structure comprises:

a plurality of stacked high impedance layers, each presenting a high impedance surface to the E field component of a different respective electromagnetic beam operating frequency and being transparent to the E fields of lower operating frequency signals, and presenting a low impedance surface to the E field of higher operating frequency signals; and

the bottommost said layer presenting a high impedance surface to the E field of the lowest frequency of said operating signals, and each succeeding layer presenting a high impedance surface to the E field of successively higher operating frequencies.

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18. The shutter switch of claim 16, wherein corresponding conductive strips of said high impedance layers are aligned along the guide longitudinal axis and said high impedance layers further comprise conductive vias through said dielectric substrates between said aligned conductive strips and said conductive layer.

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20. The shutter switch of claim 16, wherein each of said high impedance layers presents a series connection of resonant parallel L-C circuits to the E field of its respective operating frequency.

22. The shutter switch of claim 16, wherein said high surface impedance wall structures are on said waveguide's sidewalls and present a high impedance to the E field component of said different frequency beams having vertical polarization.

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23. The shutter switch of claim 16, wherein said high impedance wall structures are on said waveguide's top and bottom walls and present a high impedance to the E field component of said different frequency beams having horizontal polarization.

24. The shutter switch of claim 16, wherein said high impedance structures are on said waveguide's sidewalls and top and bottom walls and present a high impedance to the E field component of said different frequency beams having both vertical and horizontal polarization.

25. The shutter switch of claim 17, further comprising shorting arrangements on each of said plurality of layers

to change said high surface impedances to a conductive surfaces by shorting said gaps between said conductive strips.

26. The shutter switch of claim 25, wherein said shorting arrangements comprises micro electromechanical systems (MEMS) switches.

27. The shutter switch of claim 26, wherein each of said MEMS switches comprises a shorting strip suspended over said gap between a respective pair of said conductive strips, said switch being closed by applying a voltage potential to adjacent electrodes creating an electrostatic tension that pulls said shorting strip down to said conductive strips to form a conductive bridge across said gap between said conductive strips.

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28. The shutter switch of claim 25, wherein said shorting switches comprise varactor diode in each of said gaps.

29. The shutter switch of claim 28, wherein each of said varactor diode places a variable capacitance across its respective said gap such that a voltage may be applied to detune the parallel L-C circuits away from said operating frequency thus rendering said high surface impedance to a low impedance state.

30. The shutter switch of claim 28, wherein said shorting arrangements are closed on selective layers of said high impedance structures to block transmission one or both polarities of said beam at one or all of said different frequency signals.

31. A millimeter beam transmission system, comprising;

an electromagnetic beam transmitter;

an electromagnetic beam receiver;

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a shutter switch positioned in the path of said beam between said transmitter and receiver, said shutter switch comprising at least one waveguide positioned to receive at least part of said beam, the longitudinal axis of each of said waveguides aligned with the propagation of said beam, each of said waveguide having sidewalls with alterable impedance properties to either transmit or block transmission of its respective portion of said beam.

33. A millimeter beam transmission system, comprising;

an electromagnetic beam transmitter;

an electromagnetic beam receiver;

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a shutter switch positioned in the path of said beam between said transmitter and receiver, said shutter switch comprising at least one waveguide positioned to receive at least part of said beam, the longitudinal axis of each if said waveguides aligned with the propagation of said beam, each of said waveguide being switchable to either transmit or block transmission of its respective portion of said beam, wherein each said waveguide comprises:

four wall inner surfaces comprising two opposing sidewalls and a top and bottom wall;

a high impedance wall structure on at least two opposing walls of said waveguide, said wall structure presenting a high surface impedance to E fields transverse to the waveguide axis and tangential to the wall structure, and a low impedance to E fields parallel to the waveguide axis; and

shorting arrangements on each said high impedance structure to change the high surface impedance of said

structure to a low impedance surface.

34. The system of claim 33, wherein each said waveguide has inner dimensions such that the transmission of said electromagnetic beam is cut-off when said waveguide sidewalls and top and bottom walls are low impedance surfaces.

35. The system of claim 33, wherein each said high impedance wall structure comprises:

a sheet of dielectric material having two sides;

a conductive layer on one outer side of said dielectric material;

a plurality of mutually spaced parallel conductive strips on the other inner side of said dielectric material; and

a plurality of conductive vias extending through said dielectric material between said conductive layer and said conductive strips.

37. The system of claim 36, wherein said conductive strips, vias and dielectric material present a series connection of parallel L-C circuits to an electromagnetic wave with an E field transverse and tangential to said conductive strips.

38. The system of claim 36, wherein said shorting arrangements change said high surface impedance structure to a low impedance surface by shorting said gaps between said conductive strips.

39. The system of claim 33, wherein said high impedance wall structure comprises:

a plurality of stacked high surface impedance layers,

each presenting a high surface impedance to the E field component of a different respective electromagnetic beam operating frequency and being transparent to the E fields of lower frequency signals, and presenting a low impedance surface to the E field of higher frequency signals; and

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the bottommost said layer presenting a high surface impedance to the E field of the lowest frequency of said signals, and each succeeding layer presenting a high surface impedance to the E field of successively higher frequencies.

40. The system of claim 39, wherein each said layer presents a series connection of resonant parallel L-C circuits to the E field of its respective signal operating frequency.

42. The system of claim 39, wherein corresponding conductive strips of said layers are aligned along longitudinal axis of said guide and said high impedance structure further comprises conductive vias through said dielectric substrates between said aligned conductive strips and said conductive layer.

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43. The system of claim 39, wherein said shorting arrangements change said high surface impedance structure to a low impedance surface by shorting said gaps between said conductive strips.

44. The system of claim 33, wherein said high impedance structure are provided on said waveguide's sidewalls and present a high impedance to a transverse and tangential E field component of vertically polarized beams at one or more operating frequencies.

45. The system of claim 33, wherein said high impedance structure are provided on said waveguide's top and bottom walls such that said high impedance structure presents a high surface impedance to an E field component of a horizontally polarized beams at one or more operating frequencies.

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46. The system of claim 33, wherein said high impedance structures are provide on said waveguide's sidewalls and top and bottom walls and present a high impedance to the E transverse and tangential field components of a vertically and horizontally polarized beams at one or more operating frequencies.

47. The system of claim 46, wherein said shorting arrangements are closed on selective layers of said high impedance structures to block transmission one or both polarities of said beam at one or all of said different operating frequency signals.

52. A method of switching an electromagnetic beam, comprising:

transmitting said beam through one or more waveguides; and

switching the walls of said waveguides between high surface impedance and low surface impedance states to control the propagation of said beam, wherein said electromagnetic beam is horizontally and/or vertically polarized, and has different operating frequencies, the switching of the walls between high surface impedance and low surface impedance states controls propagation of said beam at different operating frequencies and polarizations.

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